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SUSTAINABLE AQUAPONICS IN SOUTH AFRICA HOBBY OR COMMERCIAL REALITY?

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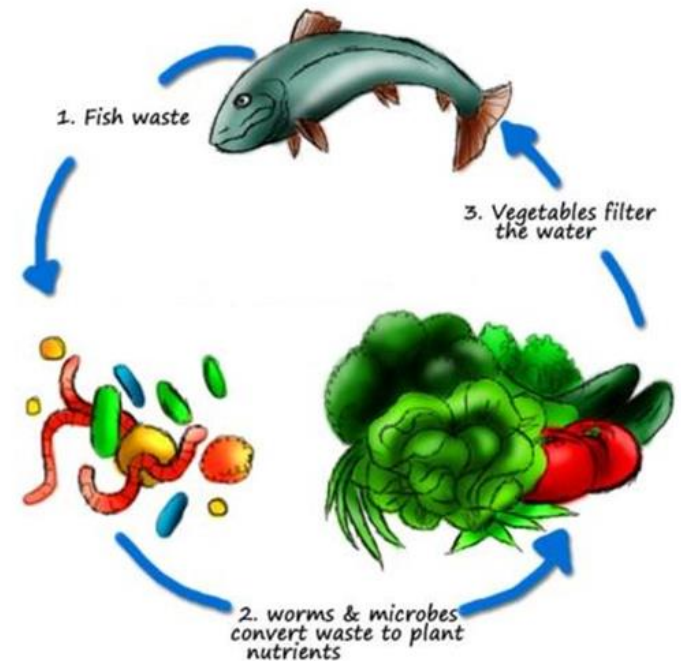




Content:



1. Introduction
2. Historic research
3. Recent research
4. Current aquaponic research facilities at US
5. Commercial system examples
6. Economic considerations
7. New plant varieties
8. Future research focus
9. Training and extension
10. Conclusion





I. Introduction:



Stellenbosch

How Aquaponics Creates Benefit for All



We can create benefit for all when we look at how aquaponics impacts the people and planet while creating prosperity for all.

Triple-Bottom Line	Community Stakeholders						
	<i>Community Members (Children, Adults, Elders)</i>	<i>Education</i>	<i>Business & Industry</i>	<i>Government</i>	<i>Banking & Investment</i>	<i>Healthcare & Wellness</i>	<i>Media</i>
PEOPLE	<ul style="list-style-type: none"> Increase access to affordable, healthy, fresh, organic GMO free food 	<ul style="list-style-type: none"> Connect people to new sustainable knowledge and develop local community learning resources 	<ul style="list-style-type: none"> Partner with existing industry leaders and Community Stakeholders to build new products, services and solutions 	<ul style="list-style-type: none"> Establish policies to support thriving local food and healthcare networks based on sustainable practices 	<ul style="list-style-type: none"> Provides long term financial security through local, sustainable and renewable investments 	<ul style="list-style-type: none"> Increase use of preventative practices that include proper nutrition and natural remedies 	<ul style="list-style-type: none"> Showcase unique ideas and solutions that inform and build new relationships that strengthen local communities
PLANET	<ul style="list-style-type: none"> Grow food and medicine anywhere (indoors, outdoors, rural, urban and suburban environments) 	<ul style="list-style-type: none"> Showcase living examples of high-yield systems that use a fraction of water than conventional farming 	<ul style="list-style-type: none"> Reduce transportation costs by creating local businesses and infrastructure 	<ul style="list-style-type: none"> Protect sustainable industries and infrastructure that preserves our natural resources 	<ul style="list-style-type: none"> Develop a greener economy while supporting local green industries and jobs 	<ul style="list-style-type: none"> Support healthy solutions that factor in the impact on the planet 	<ul style="list-style-type: none"> Feature how sustainable solutions create a positive impact on the planet and the local community
PROSPERITY	<ul style="list-style-type: none"> Increase quality of life and participate new green jobs and economic opportunities 	<ul style="list-style-type: none"> Offers new educational programs to support an emerging green industry 	<ul style="list-style-type: none"> Develop green products and services that generates livable wage jobs while creating access to new customers and markets 	<ul style="list-style-type: none"> Commitment to food purity, food security and food sovereignty. 	<ul style="list-style-type: none"> Create diversified portfolios that leverages the local food and agriculture movement 	<ul style="list-style-type: none"> Participate and develop new empowering healthcare models through local food and medicine 	<ul style="list-style-type: none"> Create local media channels that focus on organic food, holistic medicine and green industries



2. Historic research:



- Philippe Lapere
- Industrial Engineering
- December 2010
- Masters degree
- Techno-Economic Feasibility Study into Aquaponics in SA

A Techno-Economic Feasibility Study into
Aquaponics in South Africa

by
Philippe Lapere

*Thesis presented in partial fulfillment of the requirements for the degree
Master of Science in Engineering (Engineering Management) at the
University of Stellenbosch*

Supervisor: Mr. Theuns Dirkse van Schalkwyk
Faculty of Engineering
Department of Industrial Engineering

December 2010



2. Historic research:



- Study to investigate the feasibility of current aquaponic systems in South Africa
- Case studies were done on 4 farms
- Farms produce tilapia and vegetable varieties
- No current market for tilapia
- The results indicated that the majority (3 out of 4) of the farms are not economically viable. The one farm did perform reasonably well, but a number of assumptions were made which positively influenced the outcome



2. Historic research:



Sequence to determine the feasibility of an aquaculture operation:

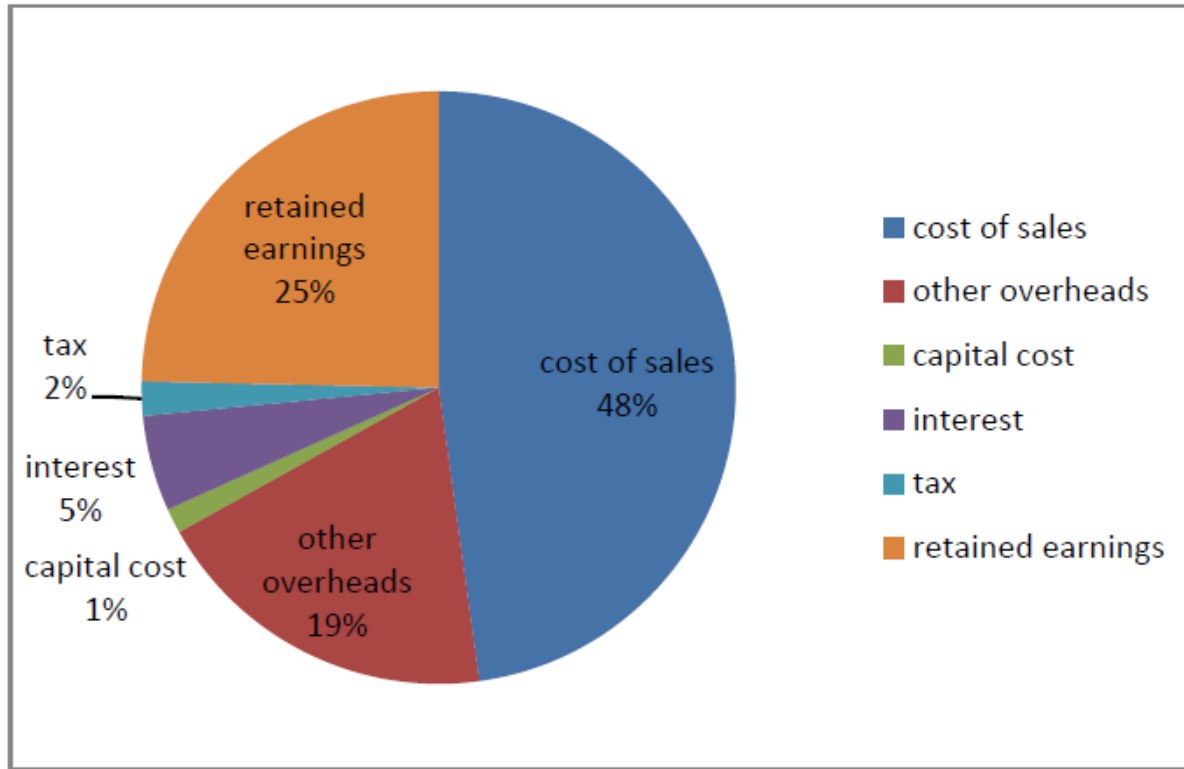
- Calculate the growth projections of the fish species;
- Calculate the capital cost of the system;
- Calculate the operational cost of the system;
- Project the sales;
- Combine the above calculations into financials in order to determine whether the venture will be financially viable



2. Historic research:



A breakdown of the sales generated on farm:



- It was noted that the farms that spend a high proportion of their costs on capital purchases and interest on debt are also the farms that perform poorly in terms of net present value indicator.



3. Recent research:



PRODUCTION OF LEAFY VEGETABLES AND HERBS USING AN AQUAPONICS SYSTEM IN THE WESTERN CAPE OF SOUTH AFRICA

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1. INTRODUCTION

The production of leafy vegetables and herbs using aquaponics systems is on the increase (Jain and 2017). This production method is a way to improve food security in a sustainable way, supplying food from areas with no water, with the use of limited water supply and land resources. Crop production is determined by environmental factors such as temperature and light intensity, but also by the availability of nutrients. In an aquaponics system the plant nutrient supply from the fish excretion of soluble and insoluble organic compounds the water is broken down to new form by bacteria in the plants. The concentration of these nutrients increases (nutritional) regularly or increases special plant growth. The objective of this study was to investigate the growth and yield responses of different crops planted at different planting densities in a hydroponics system under high light intensity and high temperature conditions in an aquaponics system with the African Drumstick (*Croton tiglium*) as the aquaponics system.

2. METHODS & MATERIALS

Three crop plants (cucumber, a specialty vegetable production at the Aquaponics Experimental Farm, Three weeks crop growth and continuous seedlings were transplanted on the 23rd January 2021 (cucumber) and on the 30th day crop growth for the cucumber and other two species and the plants were planted at a density of either 16 plants per m² (high density) (HD) or 14 plants per m² (low density) (LD) in a randomized block design. The fish rearing system consisted of two 120 L fish tanks with circulating approximately 300 l/m³ water. Cucumber, Cabbage and the other two crops were planted in the fish tanks. The fish rearing system was equipped with additional oxygenating and aerating equipment, including the fish rearing tanks and the other two tanks, and the pH and EC in each of the growing beds was measured daily and a full nutrient analysis of the water taken in the fish and water of the growing beds was used for chemical analysis every week.

3. RESULTS & DISCUSSION

Significant analysis of the effect of the growing bed nutrient level on the growth rate of the cucumber and other two species in hydroponics systems which is not lower than the recommended for the species (Table 1).

Nutrient	Recommended concentration (mg/L)			
	NO ₃ ⁻	PO ₄ ³⁻	K ⁺	Ca ²⁺
Recommended (cucumber)	100	10	10.0	4.0
Recommended (cabbage)	87	8.0	8.0	3.0
Recommended (lettuce)	50	5.0	5.0	2.0
Measured concentration	110	11.0	11.0	4.5

The nutrient NO₃⁻ and potassium (K⁺) concentrations were not more than 10% of the recommended rate for growing system and the PO₄³⁻ concentration was significantly lower than the recommended application rate for cucumber and lettuce growth in hydroponics system. The measured nutrient concentration in the aquaponics system was not lower than the recommended for the species (Table 1).

With the plant grown in the aquaponics system, the plant growth rate was comparable to the two planting densities, the yield of the cucumber was significantly lower at the higher planting densities (density) as a result of these nutrient concentrations being below the recommended rate (Table 2). It may therefore be necessary to supplement nutrient under these conditions. The crop will be repeated under other conditions again.

4. CONCLUSION

Significant yield can be obtained from leafy vegetables and herbs in an aquaponics system during periods extended with the growth rate. For crops with a higher planting density (high) to be planted in the growing system, the nutrient level is lower than the recommended rate.

5. REFERENCES

Cookson H.G., Koppes E. 2011. Market value management and profitability analysis of aquaponics. Stellenbosch, South Africa.
 Jain D.C., An P., Garg S., Kaur R., Prasad S. 2017. A comprehensive survey of aquaponics production.
 Aquaponics. Cals. 6 (2008). Growth yield, fruit quality and nutrient uptake of hydroponically cultured tomato (cv. 'Mortgage') cultured in aquaponics system and growing medium. Science Horticulturae 100: 225-232.

EVALUATION OF THE PERFORMANCE OF DIFFERENT VEGETABLE VARIETIES IN AN AQUAPONIC SYSTEM WITH RED TILAPIA (*Oreochromis mossambicus*) AND KOI CARP (*Cyprinus carpio haematopterus*).

STANDER H.S.¹, SALIS K., VAN STAPPEN O.² & WIKESA WU.¹

¹ Aquaculture Division, Department of Animal Sciences, University of Stellenbosch, South Africa.
² Faculty of Bioscience Engineering, University of Ghent, Belgium.

1. INTRODUCTION

In order to the security of aquaponics to address the United Nations Sustainable Development Goal number one an evaluation of various variety and longer the research focuses on the quality of the vegetables produced in the aquaponics system. In aquaponics, fish excretion is used as a natural fertilizer for the plants. The fish excretion is broken down by bacteria in the plants to a form that is available to the plants. The concentration of these nutrients increases (nutritional) regularly or increases special plant growth. The objective of this study was to investigate the growth and yield responses of different crops planted at different planting densities in a hydroponics system under high light intensity and high temperature conditions in an aquaponics system with the African Drumstick (*Croton tiglium*) as the aquaponics system.

2. OBJECTIVES

The research was aimed at evaluating the performance of different vegetable varieties in different planting densities in an aquaponics system with red tilapia and koi carp.

3. MATERIALS & METHODS

A survey was done in the aquaponics system to evaluate the potential of different vegetable varieties in the aquaponics system. The survey was followed by the growing of different vegetable varieties in the aquaponics system. The varieties were: Cucumber (Cucumis sativus), Cabbage (Brassica oleracea), and Lettuce (Lactuca sativa). The plants were planted in the aquaponics system at two planting densities: 16 plants per m² (high density) and 14 plants per m² (low density). The fish rearing system consisted of two 120 L fish tanks with circulating approximately 300 l/m³ water. The fish rearing system was equipped with additional oxygenating and aerating equipment, including the fish rearing tanks and the other two tanks, and the pH and EC in each of the growing beds was measured daily and a full nutrient analysis of the water taken in the fish and water of the growing beds was used for chemical analysis every week.

4. RESULTS & DISCUSSION

The yield of the cucumber was significantly lower at the higher planting densities (density) as a result of these nutrient concentrations being below the recommended rate (Table 2). It may therefore be necessary to supplement nutrient under these conditions. The crop will be repeated under other conditions again.

5. CONCLUSION & RECOMMENDATIONS

- It is not sustainable to operate an aquaponics system in the low season without an additional feeding system.
- Due to the high yield rate, it is not sustainable to operate the aquaponics system without an additional feeding system.
- There is a need to investigate the growth and yield responses of different vegetable varieties in an aquaponics system.
- It is not sustainable to operate an aquaponics system in the low season without an additional feeding system.
- The nutrient level of 11 mg/L per m² per m² is not sustainable to operate an aquaponics system in the low season without an additional feeding system.
- The data show that the yield of the aquaponics system is significantly higher at a density of 11 (although it is not the best density).
- Information and more papers need to be published on the aquaponics system.



3. Recent research:



Integrating Aquaculture with Crop Systems

An Aquaponic Enterprise Project Proposal for the Ntinga Multipurpose Co-Operative in Phillippi, South Africa

by
Marnus van der Merwe

Thesis presented in partial fulfilment of the requirements for the degree of Master of Philosophy in Sustainable Development in the Faculty of Economic and Management Sciences at Stellenbosch University



Supervisors: Gareth Haysom and Henk Stander

March 2015

MODULAR AQUAPONIC SYSTEMS

CAN ONE SIZE FIT ALL?

AUTHORS: SOLEIL JONES, MIKE HOWARD & HERMAN WIECHERS
1 AECOM SA (Pty) Ltd 2 Duke Ngqweni Wierchen Environmental Consultants (Pty) Ltd

Abstract
Aquaponic systems are highly variable in design, technology and layout. Some work, others do not. Some require high technology skills, but many cannot produce value to support them. Site specific, local, climatic conditions, inherent pressure such as global warming, oil prices or impact on the oceans or future of aquaponic systems, through production and failure in the commercial marketplace are generally overlooked for use by others. It is time to assist farmers, commercial or government, to better manage the environmental conditions, to make the aquaponic system their own design, which can be controlled according to financial conditions. The most common constraints on the basic modular system can occur in a wide range of species, and a wide range of aquaponic systems have been used with the Agricultural Research Council in South Africa. The pilot plant modules are being tested with freshwater tilapia (Oreochromis mossambicus) and rainbow trout (Salmo gairdneri) and the high pressure in water, lower pH and low levels of dissolved oxygen are being tested with freshwater tilapia. The pilot plant modules are being tested with freshwater tilapia (Oreochromis mossambicus) and rainbow trout (Salmo gairdneri) and the high pressure in water, lower pH and low levels of dissolved oxygen are being tested with freshwater tilapia. The pilot plant modules are being tested with freshwater tilapia (Oreochromis mossambicus) and rainbow trout (Salmo gairdneri) and the high pressure in water, lower pH and low levels of dissolved oxygen are being tested with freshwater tilapia.

Preliminary Aquaponic Decision Support

Climate	Temp	Humidity	Water	Species
PA-1	Hot	Low	High	Tilapia
PA-2	Hot	High	Low	Tilapia
PA-3	Hot	Low	Low	Tilapia
PA-4	Hot	High	High	Tilapia

Temp	Humidity	Water
Hot	Low	High
Hot	High	Low
Hot	Low	Low
Hot	High	High

Plant Name	Media Type	Field Requirement	Value	Harvest Season
BRASSICA (CABBAGE)	C	100 PER PLANT	MEDIUM	SPRING
BRASSICA (CABBAGE)	C	200 PER PLANT	HIGH	WINTER
BRASSICA (CABBAGE)	C	300 PER PLANT	HIGH	WINTER
BRASSICA (CABBAGE)	C	400 PER PLANT	HIGH	WINTER
BRASSICA (CABBAGE)	C	500 PER PLANT	HIGH	WINTER
BRASSICA (CABBAGE)	C	600 PER PLANT	HIGH	WINTER
BRASSICA (CABBAGE)	C	700 PER PLANT	HIGH	WINTER
BRASSICA (CABBAGE)	C	800 PER PLANT	HIGH	WINTER
BRASSICA (CABBAGE)	C	900 PER PLANT	HIGH	WINTER
BRASSICA (CABBAGE)	C	1000 PER PLANT	HIGH	WINTER
BRASSICA (CABBAGE)	C	1100 PER PLANT	HIGH	WINTER
BRASSICA (CABBAGE)	C	1200 PER PLANT	HIGH	WINTER
BRASSICA (CABBAGE)	C	1300 PER PLANT	HIGH	WINTER
BRASSICA (CABBAGE)	C	1400 PER PLANT	HIGH	WINTER
BRASSICA (CABBAGE)	C	1500 PER PLANT	HIGH	WINTER
BRASSICA (CABBAGE)	C	1600 PER PLANT	HIGH	WINTER
BRASSICA (CABBAGE)	C	1700 PER PLANT	HIGH	WINTER
BRASSICA (CABBAGE)	C	1800 PER PLANT	HIGH	WINTER
BRASSICA (CABBAGE)	C	1900 PER PLANT	HIGH	WINTER
BRASSICA (CABBAGE)	C	2000 PER PLANT	HIGH	WINTER

SPACE AVAILABLE	MAX NUMBER OF TANKS	MAX STOCKING RATE	MAX HARVEST
MAX HARVEST	MAX TAN	MAX BIOPLET VOLUME	MAX BIOPLET TANKS
MAX BIOPLET TANKS	MAX FEED TANKS	MAX PUMP RATE	MAX NUMBER OF PLANTS
MAX HYDROPONIC FEED TANKS	MAX GRAVEL BEDS (20MM)	AREA REQUIRED	
MAX DEP THROUGH (RASH 100)	AREA REQUIRED		

PICK AND CHOOSE MODULES	OPERATION	BANK	NUMBER	COST	STARTS	ENDS	MARKS	COST
ROV TANKS	ROV	1	1000	1000	1000	1000	1000	1000
ROV TANKS	ROV	2	2000	2000	2000	2000	2000	2000
ROV TANKS	ROV	3	3000	3000	3000	3000	3000	3000
ROV TANKS	ROV	4	4000	4000	4000	4000	4000	4000
ROV TANKS	ROV	5	5000	5000	5000	5000	5000	5000
ROV TANKS	ROV	6	6000	6000	6000	6000	6000	6000
ROV TANKS	ROV	7	7000	7000	7000	7000	7000	7000
ROV TANKS	ROV	8	8000	8000	8000	8000	8000	8000
ROV TANKS	ROV	9	9000	9000	9000	9000	9000	9000
ROV TANKS	ROV	10	10000	10000	10000	10000	10000	10000

MAX HARVEST (ROV)	PRICE PER KG	WHOLE FISH	INCOME
PRICE PER KG <td>PRICE PER KG</td> <td>PRICE</td> <td>INCOME</td>	PRICE PER KG	PRICE	INCOME
MAX HARVEST (PLANT) <td>PRICE PER KG <td>PRICE</td> <td>INCOME</td> </td>	PRICE PER KG <td>PRICE</td> <td>INCOME</td>	PRICE	INCOME
DRIP THROUGH <td>PRICE PER KG <td>PRICE</td> <td>INCOME</td> </td>	PRICE PER KG <td>PRICE</td> <td>INCOME</td>	PRICE	INCOME

NO FEED WATER QUALITY AND NUTRIENT LEVELS BETWEEN 2005 - 2009 AS IT FALLS REQUIREMENTS IN THE AECOM REPORTS, RESEARCH AND SURVEY OF WATER QUALITY.
 SOURCE: JONES, S.J., JONES, M.H. & WIECHERS, H. (2015). ASIA JEMP Aquaponic Research and Development Project: Final Report and Business Plan. Stellenbosch University.
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3. Recent research:



Aquaponics - The Synaptoman way

Aquaponics

The Synaptoman way



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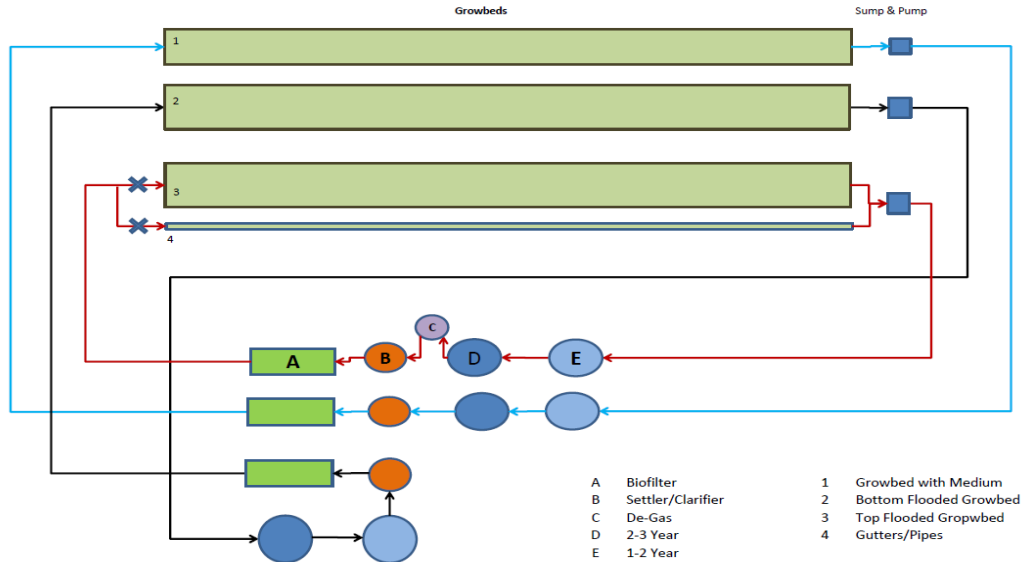




4. Current aquaponic research facilities:



System I:



System 2:





4. Current aquaponic research facilities:





5. Commercial system examples:





6. Economic considerations:



- Design the system to the best of your ability and improve over time
- Space and resources must be used efficiently
- Stocking densities, pond size, area of hydroponic growth should be calculated scientifically
- Do enough market research
- Do value adding on your products if possible
- Explore Agri-tourism
- Target niche markets
- Diversify your production
- Select the appropriate fish species
- Select the correct high value plant varieties
- Keep input cost as low as possible
- Make use of renewable energy





7. New plant varieties:





8. Future research focus:

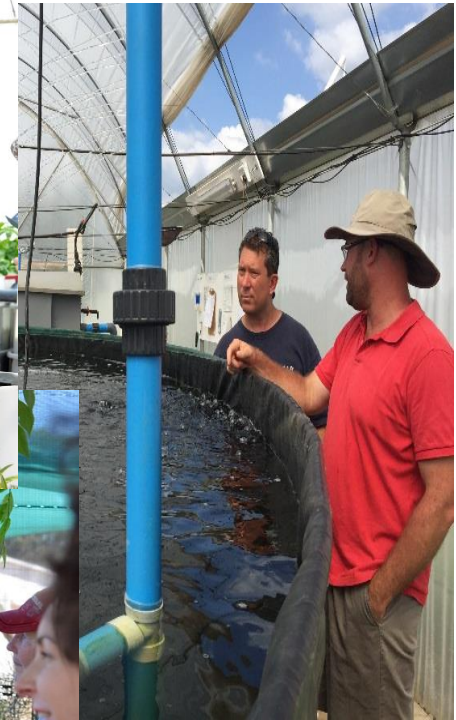


- Optimization
- Economic sustainability
- Renewable energy
- Energy efficiency
- Pest control on plants
- New product development
- System design
- Nutrient supplementation
- Artificial fish feed





9. Training and extension:





10. Conclusion:



- Aquaponics is the future!
- Keep living the dream!
- All the best with your Aquaponic Research!

